Tapping of *Pinus Roxburghii* (Chir Pine) for Oleoresin in Himachal Pradesh, India

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Abstract

The oleoresin is an important forest produce of pine forests in the world. The variation in the economics of resin tapping (oleoresin yield, cost of production) and oleoresin quality is influenced by method of tapping and chemical stimulants used for tapping, diameter of trees. Resin flow, a typical defense response in conifers, is controlled by various environmental factors. Different concentrations of Ethephon, sulphuric acid (isolated or in combination with CEPA) have also been tested. Higher resin yields were associated with summer, whereas rainy season had lower oleoresin yield. Ethephon in combination with sulphuric acid enhanced the oleoresin yield as compare to the isolated treatments. Trees exposed to stimulant ethephon 10%+20% H2SO4 resulted in higher oleoresin yields. Trees with larger diameter at breast height (38-40 cm) yielded more oleoresin than their smaller counterparts (30-32 cm). The oleoresin yield showed significant increase with increment in diameter of boreholes. In conclusion, cost reductions on resin tapping can be achieved by adjusting concentration of chemical stimulant, diameter of boreholes and managing subsets of trees in specific fashion based on DBH ranges.

Keywords

Oleoresin; Chir Pine; Chemical Stimulant; Tree Diameter; Borehole Diameter; Season

Introduction

Pinus roxburghii, known as Chir pine, as the most important species in India covering an area of 8900 square km (Sharma, 2002), whose distribution extends longitudinally from 71^o-93^oE and latitudinally from 26^o-36^o N, grows between 450-2300 m above mean sea level, with the best forests between 650 to 1500 m above mean sea level. Chir pine forests are found in the provinces of Jammu and Kashmir, Himachal Pradesh, Uttaranchal, West Bengal and Arunachal Pradesh. It occupies an area of 158,813 ha in Jammu and Kashmir, 412,000 ha in Uttaranchal (U.P.) (Singh *et al.*, 1988). In Himachal Pradesh, it is distributed in Hamirpur, Bilaspur, Kangra, Mandi, Solan, Sirmour and Shimla districts, covering an area of 1,36000 lac hectares (Anonymous, 1990).

Chir pine is the primary species commercially tapped for oleoresin in India. Oleoresin production is important for the oleoresin based industries and responsible for employment of large numbers of rural people. The availability of adequate number of mature pine trees is the fundamental requirement for smooth running of the oleoresin tapping work and thereby the dependent industries. The fluctuations in oleoresin yield invite import, which ultimately disturbs the economy of the country. Turpentine oil holds a wide variety of industrial uses such as in perfumery industry, pharmaceutical preparations, synthetic pine oil, disinfectants and denaturants. It is a very versatile material and currently used mainly as feedstock by the world's chemical industries. The alpha-pinene and beta-pinene constituents of turpentine are the starting material of a wide range of fragrance, flavours, vitamins and polyterpene resins and form the basis of a substantial and growing chemical industry. Rosin is chiefly used in paper, soaps, detergents, cosmetics, paints, varnish, rubber and polish industries. It is also used in manufacture of linoleum explosives, insecticides and disinfectants. Oleoresin production in India increased up to 1975-76 and then decreased to less than 25,000 tones in 1990-91. During 1994-95, it was estimated in between 25,000-30,000 tones (Coppen and Hone, 1995).

The normal resin canals are longitudinal and the transverse canals are always included in the fusiform rays. The oleoresin is synthesized in the epithelial cells of the canal and adjoining living parenchymatous cells. When the tree is tapped/injured, the cell exerts exudation pressure into the lumen of canal and this pressure is responsible for exudation of oleoresin. The yield of oleoresin is affected by number of factors such

as diameter, tree crown, growth rate, inherited capacity of individual, environmental factors, time of tapping, stimulants, width of blaze and diameter and depth of boreholes etc. (Kedarnath, 1971, Verma and Pant, 1978 and Hodges, 1995).

Materials and Methods

The present investigation was conducted during 2001 and 2002 under the auspices of the Department of Forest products at Dr.Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan. The oleoresin tapping was done from April to October. The area of investigation is situated at an altitude of 1200-1225 m above mean sea level, and lies at 30°1´N latitude and 76° 11´E longitude. The climate of the area ranges from sub-tropical to sub-temperate with an annual rainfall varying from 1000-1300 mm and temperature ranging from 2-20°C in winters and 20-33°C in summers. The site receives moderate frost during winters.

FIG.1 BOREHOLE METHOD

The plantation was divided into 5 diameter classes viz. 30-32, 32-34, 34-36, 36-38 and 38-40cm and 20 trees were marked in a diameter class selected from four replicates located on four aspects viz North-East, East, South-East and South, so each replicate had five trees. In each tree, one hole was drilled approximately 10 cm above the ground. Hand driven drill bits of 1.25 cm (0.50 inch), 1.87 cm (0.75 inch), 2.50 cm (1 inch) and 3.125 cm (1.25 inch) diameter were used for drilling holes. The holes were drilled with slight slope towards opening, so that oleoresin drained freely. The chemical stimulant was sprayed with the help of a simple spray bottle with nozzle. Spouts or small pieces of pipes were fixed in the holes tightly, and plastic bags made of high density polyethylene (HDPE) were attached to the spout of each hole with the help of a tie for collection of oleoresin and replaced only when filled with oleoresin during the period of tapping. The data recorded for oleoresin yield was statistically analyzed by using Randomized Block Design (Panse and Sukhatme, 1967 and Chandel, 1998).

Results and Discussion

The significant difference has been noticed in oleoresin yield among different diameter classes. The highest oleoresin yield of 1304 g/hole/tree was recorded from the trees of 38-40 cm diameter class and the lowest oleoresin yield of 865 g/hole/tree was found in 30-32 cm diameter trees. Mathauda (1961), Lohani (1968), Kaushal *et al.* (1983), Kaushal and Sharma (1988), Chaudhari *et al.* (1992), Singhal (1996) and Murtem (1998) have also reported that diameter has positive and significant effect on oleoresin yield in *Pinus roxburghii.*

The exudation of oleoresin from resin ducts ceases after some time as they get plugged. Water plays an important role in cellular turgescence leading to the occlusion of canals by swelling the epithelial cells. So the chemical stimulants are sprayed to keep the ducts open for longer period so that resin keeps on flowing. It is evident from the data presented in Table 2 that the application of stimulants has significantly increased the oleoresin yield. With the increase in concentration of ethephon (2-chloroethylphosphonic acid), the oleoresin yield has also increased. Ethephon releases ethylene, which may trigger stimulation of oleoresin synthesis in existing resin ducts, and also induces the formation of traumatic resin ducts. Wolter and Zinkel (1984) has also reported that number of resin ducts in wood after paraquate (ethephon) treatment increased, adding to the resin producing capacity in red pine(*Pinus resinosa*). The increase in oleoresin yield with ethephon has also been reported by Stephan (1985) in slash pine, Anthkowiak (1992) in *Pinus sylvestris* (Scots pine*)* Wolter (1977) in red pine (*Pinus resinosa*).

Similarly with increase in sulphuric acid concentrations, the oleoresin yield is also increased. Sulphuric acid increases yield by prolonging flow to reduce the turgescence of epithelial cells due to tapping injury, preventing crystallization of resin acids and formation of tylosiods (Kossuth, 1984). The increase in oleoresin yield by sulphuric acid concentrations has also been reported by Rajkhowa and Khan (1962), Seth and Lohani (1971), Sheikh (1978), Lohani (1984), Ribas (1986) and McReynolds and Kossuth (1985).

When the ethephon and sulphuric acid are sprayed in mixture, the highest oleoresin yield (1780 g/hole/tree) is recorded from holes treated with 10 per cent ethephon + 20 per cent H_2SO_4 and minimum (450g/hole/tree) from control (Table 1). Rawat (2000) in chir pine (*Pinus roxburghii*), Hodges and Johnson (1997) in Slash pine (*Pinus elliottii)* and McReynolds and Kossuth (1984) in slash pine (*Pinus elliottii*) have also reported similar results. McReynolds and Kossuth (1985) have observed the highest oleoresin yield in slash pine with 50 per cent H_2SO_4 + 10 per cent ethephon. Vankaiah (1991) has reported that 15 per cent ethephon+ 20 per cent H_2SO_4 mixture have resulted in higher oleoresin yield in chir pine (*Pinus roxburghii*).

The oleoresin yield was significantly affected by the wound size (Diameter of boreholes) and the season of tapping (Table 2). The significantly highest oleoresin yield (770g/hole/tree) was recorded in the month of May from all diameter boreholes followed by month of June (Table 3). This may be due to the favorable environmental conditions that are higher temperature, low rainfall, more sunshine hrs/day in this month. It is apparent from the table that the oleoresin yield is higher in summer season as compare to rainy season. Atmospheric temperature has definite role to be played in exudation of oleoresin from trees. If the temperature is low, the yield falls significantly (Anonymous, 1972). A positive and significant correlation between oleoresin yield and temperature has also been noticed by Sharma and Kaushal (1992). Similar results have been reported by Mathauda (1961), Kaushal *et al.* (1983) and Kaczmarek (1987). Kaushal *et al.* (1983) also reported that resin yield obtained during month of June (hottest month) was significantly higher than that obtained in other months during tapping season and it decreased with fall of atmospheric temperature. The oleoresin yield was found to be highest (890 g/hole/tree) in 1.25 inch diameter holes followed by 1 inch diameter holes (870g/hole/tree). The increase in yield is due to the greater volume of resinous woody tissue affected, more number of canals opened for oleoresin flow and ultimately the oleoresin yield increased. Nebeker *et al.* (1995) in lodgepole pine (*Pinus contorta*) and Hodges (1995) in slash pine (*Pinus elliottii*) have reported the increase in oleoresin yield with increment in size of surface area tapped. Various workers have experienced similar trend and have reported that the increment in surface area increases the yield up to certain limits only (Low and Abdul Razak, 1985 and Sharma, 1980). Similar results are reported by Hodges and Johnson (1997) in slash pine (*Pinus elliottii*) and Rawat (2000) in chir pine (*Pinus roxburghii*). The results are in conformity with Dulsalam *et al.* (1998) and Kaushal and Sharma (1988).

Conclusion

Under subtropical to sub temperate region of Himachal Pradesh, India higher oleoresin yields from *Pinus roxburghii* depended on diameter of trees, diameter of boreholes and concentration of chemical stimulant. Generally, the larger diameter trees were associated with higher oleoresin yield. The oleoresin yield increased with increment in concentration of chemical stimulants. The highest oleoresin yield was obtained by using 10% ethephon +20% H2SO4 as a chemical stimulant. Therefore, the use of this chemical stimulant could be attractive for oleoresin-oriented industrial forestry. The oleoresin yield increased with increment in diameter of borehole. Higher resin yields were associated with summer (April a, May and June), whereas rainy season (July, August, September and October) had lower yield. The 1.00" (2.50cm) and 1.25" (3.125 cm) diameter boreholes yielded similar amount of oleoresin, favoring the uses of 1.00(2.50cm) diameter holes. These results indicated that higher oleoresin yield and cost reduction in resin tapping operations can be achieved by adjusting the diameter of boreholes, chemical concentrations of stimulants, as well as by selecting and managing the subsets of trees based on DBH ranges in specific fashion.

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TABLE 1 EFFECT OF TREE DIAMETER AND CHEMICAL STIMULANTS ON OLEORESIN YIELD.

Chemical stimulants	**Annual Oleoresin yield (g/hole/tree)**					**Average annual oleoresin yield(g/hole/tree)**
	Diameter classes					
	30-32cm	32-34 cm	34-36 cm	36-38cm	38-40 cm	
Ethephon						
5%	475	496	680	775	950	**675**
10%	550	600	840	900	990	**775**
15%	640	725	955	1000	1030	**870**
Sulphuric acid						
10%	575	650	700	725	800`	**690**
15%	600	700	720	755	800	**710**
20%	625	780	750	825	850	**750**
Ethephon with sulphuric acid						
Ethephon 5%+H_2SO_4 10%	700	725	800	875	900	**800**
Ethephon 5%+H_2SO_4 15%	750	925	1000	1100	1225	**1000**
Ethephon 5%+H_2SO_4 20%	950	1000	1050	1150	1250	**1080**
Ethephon 10%+H_2SO_4 10%	1000	1025	1200	1400	1500	**1225**
Ethephon 10%+H_2SO_4 15%	1200	1300	1550	1850	1950	**1570**
Ethephon 10%+H_2SO_4 20%	1400	1500	1700	1900	2400	**1780**
Ethephon15%+H_2SO_4 10%	1300	1400	1550	1850	2000	**1620**
Ethephon 15%+H_2SO_4 15%	1375	1550	1625	2000	2200	**1750**
Ethephon 15%+H_2SO_4 20%	1450	1525	1700	1950	2250	**1775**
Control	250	400	450	500	650	**450**
Mean	**865**	**931**	**1080**	**1221**	**1304**	**1100**

Chemical stimulants	$SE_d(\pm)$	$CD_{0.05}$
	34.11	69.66
Diameter classes	32.00	65.20

TABLE 2 EFFECT OF SEASON AND WOUND SIZE ON OLEORESIN YIELD.

Season	**Months**	**Borehole Diameters**				
		0.50"(1.25cm)	**0.75"** (1.875cm)	**1.00" (2.50cm)**	**1.25"(3.125 cm)**	**Average monthly yield(g/hole/tree)**
Summer	April	465	485	530	535	562
	May	755	765	770	790	770
	June	700	695	660	685	685
Rainy	July	525	550	600	615	572
	August	400	425	550	560	484
	September	275	300	325	375	319
	October	200	250	300	325	268
	Mean	474	607	625	637	614

Months (M)	$SE_d(\pm)$	$CD_{0.05}$
	5.40	12.00
Borehole Diameter (d)	7.20	15.00